

# Research Summary

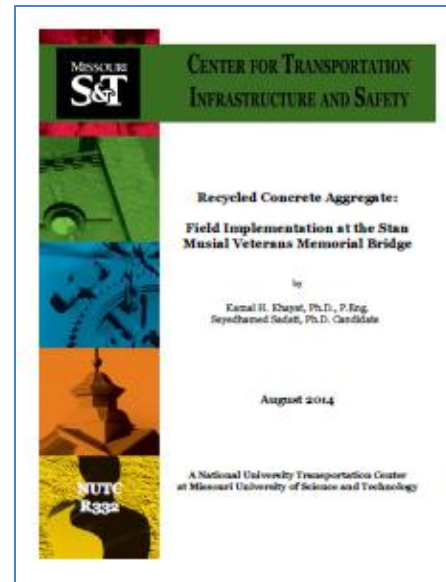
## Recycled Concrete Aggregate: Field Implementation at the Stan Musial Veterans Memorial Bridge

This research was sponsored by the [U.S. Department of Transportation, University Transportation Centers Program](#).

The project involved the field evaluation of special concrete made using recycled concrete aggregate (RCA) in the construction of an approach pavement (approximately 950 feet in length) to the Stan Musial Veterans Memorial Bridge, inaugurated in February 2014.



Researchers investigated the performance of three mixture proportions of concrete with varying amounts of RCA, water-to-cementitious materials ratios (w/cm), and Class C fly ash contents, as compared with a reference sample in order to develop a sustainable concrete



designated for rigid pavement. See Table 5-1 below.

Table 5-1. Mixture proportions of concrete used in field study

Mixture type	Reference	30% RCA	30% RCA-TSMA	40% RCA
Cement Type I (lb/yd³)	409	409	409	409
Class C fly ash, by mass (%)	25	25	25	25
Fly ash (lb/yd³)	136	136	136	136
Cementitious materials (lb/yd³)	545	545	545	545
Water (lb/yd³)	218	218	218	218
w/cm	0.40	0.40	0.40	0.40
Sand (lb/yd³)	1338	1338	1338	1338
Sand/Aggregate, by volume (%)	42.5	42.5	42.5	42.5
Coarse virgin aggregate (lb/yd³)	1811	1268	1268	1268
Coarse RCA (lb/yd³)	-	509	509	679
RCA, by mass (%)	-	30	30	40

A variety of samples were taken to investigate the mechanical properties and durability of concrete employed at the job site.

Instrumentation was embedded in pavement sections to monitor the long term deformation of different concrete mixtures incorporated in the field study. Truck load testing was conducted to evaluate deformation characteristics of RCA concrete compared to that of the Reference concrete mixture made without any RCA.





Installing sensors at the job site

Core samples were extracted to evaluate the in-situ properties of concrete.

In addition, laboratory research was conducted to investigate the performance of concrete mixtures made with different amounts of fine RCA varying from 0 to 20%, different fly ash contents ranging from 25% to 40%, and different water-to-cementitious materials ratio of 0.37 to 0.42.

The study concluded that

- 1) Using up to 40% coarse RCA in pavement application will not lead to significant decrease in performance of the mixtures;
- 2) No significant difference in 91-day rapid chloride-ion permeability was observed;
- 3) All mixtures had acceptable mechanical properties, in line with laboratory results;
- 4) Higher concentration of micro-cracks was observed in the case of RCA mixtures, which may be attributed to the crushing process during RCA production;
- 5) All mixtures exhibited low iso-thermal deformation values varying from 50 to -150  $\mu\epsilon$  after more than one year;
- 6) Increase in deformation due to traffic loading was observed in the case of the RCA mixtures; and
- 7) Decrease in deformation was observed as a result of an increase in truck loading speed.

## Project Information

**PROJECT NAME:** Recycled Concrete Aggregate: Field Implementation at the Stan Musial Veterans Memorial Bridge

**PROJECT START/END DATE:** January 2013 through June 2014

**PROJECT COST:** \$265,000

**FUNDING SPONSOR:** U.S. Department of Transportation, Research and Innovative Technology Administration

**LEAD CONTRACTOR:** Center for Transportation Infrastructure and Safety, Missouri University of Science and Technology

**PRINCIPAL INVESTIGATOR:** Kamal H. Khayat

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